ECM2418 Computer Languages and Representations
Continuous Assessment 1: Functional Programming

Dr David Wakeling

Handed out	Handed in
Friday 29th September 2017 (T1:01)	Wednesday 1st November (T1:06)

This Continuous Assessment is worth 15% of the module mark.

Work is to be submitted via BART at the Student Services Desk of the Harrison Building by midday on Wednesday 1st November 2017. **All students are reminded of the University regulations on academic honesty and plagiarism.**

You should make use of higher-order functions, and functions from the Haskell standard prelude whenever possible.

Question 1

A Roman number is a concatenation of strings from the set { "C", "CD", "CM", "D", "I", "IV", "IX", "L", "M", "V", "X", "XC", "XL" }. These strings have the values:

String	Value	String	Value	String	Value
"C"	100	"IV"	4	"X"	10
"CD"	400	"IX"	9	"XC"	90
"CM"	900	"L"	50	"XL"	40
"D"	500	"M"	1000		
"I"	1	"V"	5		

Show two Haskell functions that convert an integer to a Roman number and a Roman number to an integer, so that

```
romanToInt "MCMXCIX"
  ====> 1999

intToRoman 1999
  ====> "MCMXCIX"
```

(20 marks)

Question 2

Wikipedia defines an *alternade* to be a word in which its letters, taken alternatively in a strict sequence, and used in the same order as in the original word, make up at least two other words. All letters must be used, but the smaller words are not necessarily of the same length. Some example alternades are:

waists	$\Rightarrow$	*wit*, *ass*
board	$\Rightarrow$	*bad*, *or*
pained	$\Rightarrow$	*pie*, *and*
schooled	$\Rightarrow$	*shoe*, *cold*

Show a Haskell function that given a word and a dictionary, says whether the word is an alternade given the dictionary. Thus,

```
alternade "pained" dictionary
    ===> True
alternade "muppet "dictionary
    ===> False
```

(20 marks)

Question 3

Every day, *The Times* newspaper publishes a Suko puzzle in the form of a grid. See Figure 1.

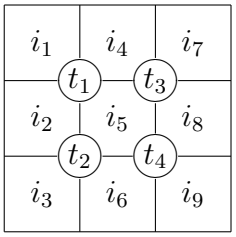


Figure 1: The Suko grid.

Given the integers t_1, t_2, t_3 and t_4, the reader is challenged to arrange the integers i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, and i_9 between 1 and 9, so that

$$\begin{aligned} t_1 &= i_1 + i_2 + i_4 + i_5 \\ t_2 &= i_2 + i_3 + i_5 + i_6 \\ t_3 &= i_4 + i_5 + i_7 + i_8 \\ t_4 &= i_5 + i_6 + i_8 + i_9 \end{aligned}$$

There are six solutions to the Suko of Monday 25th September 2017. One of these is shown in Figure 2.

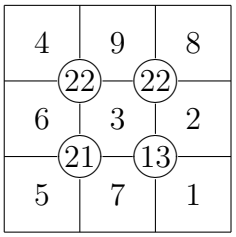


Figure 2: A Suko solution.

Show a Haskell function that given a tuple of four integers, t_1, t_2, t_3 and t_4, returns a solution list of nine integers i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, and i_9 for the Suko puzzle. Thus,

```
suko (22, 21, 22, 13)
   ===> [4,6,5,9,3,7,8,2,1]
```

(20 marks)

Question 4

A word search game looks for a number of hidden words in a grid of letters. A hidden word may be written forwards or backwards in the rows, columns and diagonals of the grid. See Figure 3.

I	U	P	G	R	A	D	E	E	P	E	Q
Y	T	D	Z	M	T	Z	V	N	R	X	S
Y	V	C	E	C	T	I	W	A	L	Z	R
P	C	P	G	E	R	S	W	G	C	R	E
P	G	L	U	D	V	D	U	C	F	N	S
O	N	T	D	J	R	R	W	D	F	O	Y
L	V	R	G	A	X	A	I	Y	F	K	Z
F	A	U	H	B	G	S	X	T	E	L	I
H	E	G	S	P	K	H	W	Y	P	O	C
T	E	S	Z	E	B	A	B	I	D	K	Y
N	Z	W	T	U	R	O	H	O	I	P	K
M	X	T	G	E	A	D	G	A	V	L	U
T	E	S	S	R	M	E	M	O	R	Y	O
D	I	Q	D	T	R	O	M	T	K	S	L
I	R	C	T	L	A	P	T	O	P	O	X

LAPTOP	KEYBOARD	BUGS	DISKETTE	UPGRADE
MEMORY	HARDWARE	FLOPPY	HARDDRIVE	SOFTWARE

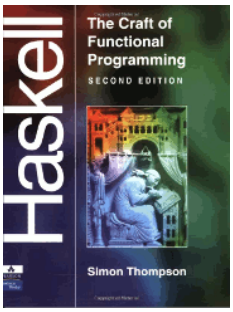
Figure 3: A word search game.

Show a Haskell function that performs a word search. For the example of Figure 3, the results might be

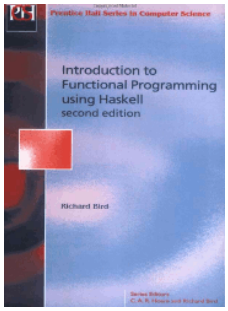
```
LAPTOP right
KEYBOARD downleft
BUGS downleft
DISKETTE downleft
UPGRADE right
MEMORY right
HARDWARE upright
FLOPPY up
HARDDRIVE upright
SOFTWARE downleft
```

(40 marks)

Readings



S. Thompson, *The Craft of Functional Programming (Third Edition)*, Addison Wesley, 2011, ISBN 978-0201882957.



R. Bird, *Introduction to Functional Programming Using Haskell (Second Edition)*, Prentice Hall, 1998, ISBN 978-0134843469.